[19]中华人民共和国国家知识产权局

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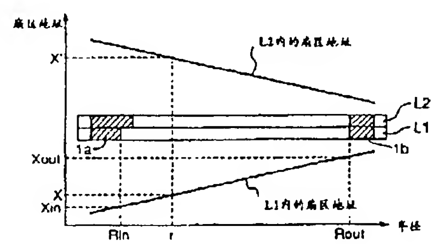
权利要求书5页 说明书17页 附图页数11页

[54]发明名称 信息记录媒体、信息再现方法和信息再现设备

[57]摘要

一种光盘，具有第一记录层和位于另一个上的第二记录层，每层上记录的信息从可以光盘一侧光学读取。在第一和第二记录层上形成光道，沿所述光道设置多个扇区。第一和第二层上的光道的图形为螺旋形，从光盘的同一侧看，所述第一和第二层上螺旋图形的卷绕方向相反。第一记录层上设置的扇区地址从最内圈向最外圈增加，设置在第二记录层上的扇区地址从最外圈向最内圈增加。在光盘半径方向上近似对应位置的第一和第二层上的扇区地址的关系为互补关系。



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这些扇区以螺旋式图形连续连接．由于记录密度是恒定的，所以从内圈到外圈每个扇区的大小(容量)是相同的．

图 11 示出了每个扇区的内部结构．每个扇区包含含有唯一识别该扇区的地址的首部、记录用户数据的数据块，以及记录再现期间用于误差校正的码的误差校正码(ECC)块。

近年来，活动图像压缩技术的进展已使它可以在单张光盘上记录基本上为电影院质量的活动图像．这些光盘也称为数字视频光盘(DVD)．

一张 DVD 可以存储近 135 分钟的高质量活动图像．然而，显然，不是所有的视频源都约为 135 分钟长．因此，已经提出在单张光盘上形成两层记录层使存储容量接近翻倍。在图 12 示出了从双记录层光盘上再现数据的原理，下面将加以描述。

在透明基片上，形成凹坑和陆面，然后用铝覆盖形成每层记录层．在第一和第二记录层之间注入透明的照相排版树脂．把第一记录层的铝厚度调节成反射入射到其上的一半光，让一半光通过．第二层记录层的铝厚度调节成反射入射到其上的所有光．靠近或离开光盘移动物镜聚焦激光束，这样激光束的光点(聚焦点)可以聚焦在第一或第二层记录层的铝上。

下面描述 DVD 媒体的记录层．与传统光盘和磁盘一样，把信息分成扇区单元，记录到 DVD 媒体上。每个记录层的 DVD 扇区结构也与如图 10 所示的 CLV 盘的结构相同．每个扇区的内部结构也与图 11 所示的传统信息存储媒体相同．

图 13A 、 13B 、 13C 和 13D 示出了上述具有两层记录层的传统信息存储媒体的螺旋式凹槽、转速和再现方向．图 13A 示出了第一层上的螺旋凹槽图形，图 13B 示出了第二层上的螺旋凹槽图形，图 13C 示出了光盘的转速，图 13D 示出了再现方向．如图 13D 所示，用户数据记录到第一和第二层的数据块上．扇区地址也记录到引入和引出区（图 3D 中阴影区所示）上，这样当光头运行过数据块上时可以确定当前的位置。

当信息存储媒体顺时针旋转时，第一和第二层记录层都从内圈向到外圈再现．信息存储媒体的转速也与半径成反比例，因此，随光头从内圈移向外圈而降低．因此，如果再现是连续地从第一层到第二层，则光头必须从外圈移到内圈，同时调整媒体的转速。

当信息存储媒体具有两层或更多层记录层时，在分配扇区地址时必须要考虑两个因素．第一，整个信息存储媒体上的每个地址必须是唯一的．如果在第一和第二层上

图 13A

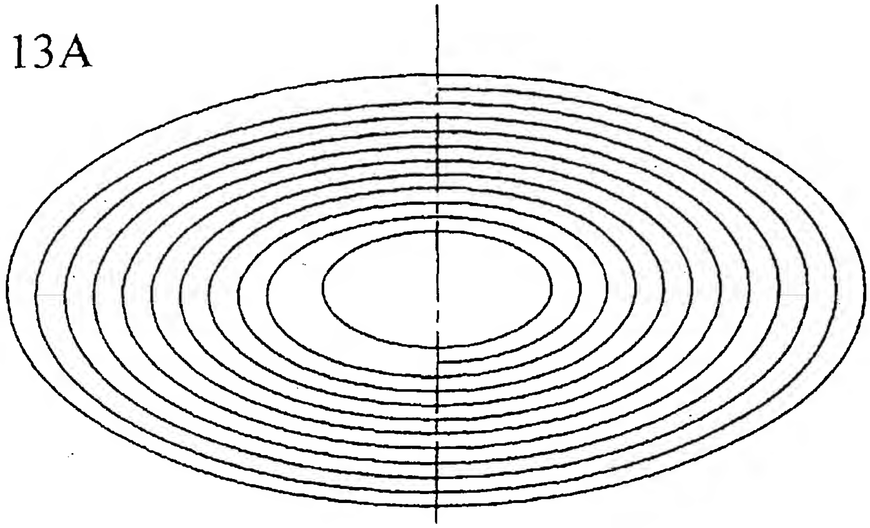


图 13B

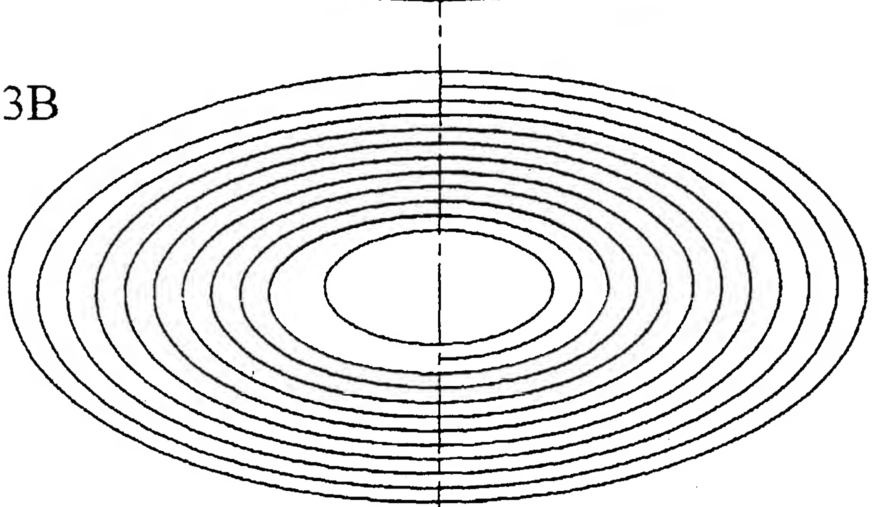


图 13C

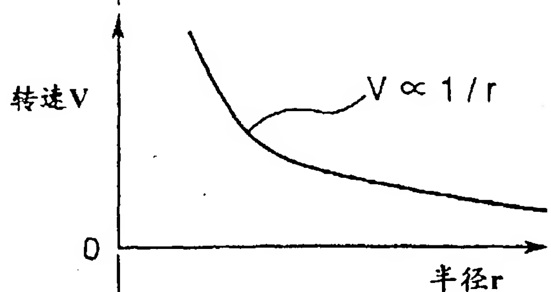
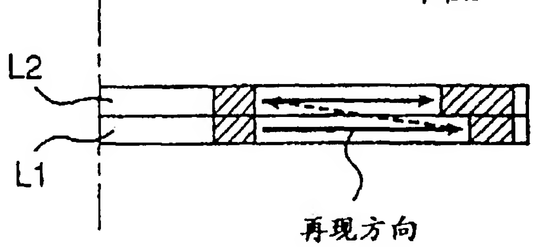


图 13D



information reproduction equipment

Patent number: CN1247622

Publication date: 2000-03-15

Inventor: YOSHIHISA FUKUSHIMO (JP); HIRO UEDA (JP); MOTOSHI ITO (JP)

Applicant: MATSUSHITA ELECTRIC IND CO LTD (JP)

Classification:

- international: G11B7/007; G11B7/00

- european:

Application number: CN19960197394 19961015

Priority number(s): JP19950270833 19951019

Also published as:

- WO9715050 (A1)
- EP0856186 (A1)
- EP0856186 (B1)

Abstract not available for CN1247622
Abstract of correspondent: **WO9715050**

An optical disk has a first recording layer and a second recording layer placed one over the other in such a manner that information recorded in each layer is optically readable from one side of the disk. Tracks are formed on the first and second recording layers with a plurality of sectors provided along said tracks. The tracks on the first and second layers are in a spiral pattern and arranged such that the spiral patterns on the first and second layers have opposite winding directions when viewed from the same side of the disk. The sector addresses provided to the first recording layer increasig from the most inside circumference to the most outside circumference, and the sector addresses provided to the second recording layer increases from the most outside circumference to the most inside circumference. The sector addresses on the first and second layers in approximately corresponding places in the radial direction of the disk are in complementary relationship.

中华人民共和国国家知识产权局

PJYL2684

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马莹 邵亚丽

发文日期

专利局 2004.4.30 发文

申请号：021064024

申请人：三星电子株式会社

发明创造名称：光盘及用于标识记录层的方法

第一次审查意见通知书

1. ☑应申请人提出的实审请求，根据专利法第35条第1款的规定，国家知识产权局对上述发明专利申请进行实质审查。
   ☐根据专利法第35条第2款的规定，国家知识产权局决定自行对上述发明专利申请进行审查。
2. ☑申请人要求以其在：
   KR 专利局的申请日 2001年04月07日为优先权日，
   专利局的申请日 年 月 日为优先权日，
   专利局的申请日 年 月 日为优先权日，
   专利局的申请日 年 月 日为优先权日，
   专利局的申请日 年 月 日为优先权日。
   ☑申请人已经提交了经原申请国受理机关证明的第一次提出的在先申请文件的副本。
   ☐申请人尚未提交经原申请国受理机关证明的第一次提出的在先申请文件的副本，根据专利法第30条的规定视为未提出优先权要求。
3. ☐经审查，申请人于：
   年 月 日提交的 不符合实施细则第51条的规定；
   年 月 日提交的 不符合专利法第33条的规定；
   年 月 日提交的
4. 审查针对的申请文件：
   ☑原始申请文件。 ☐审查是针对下述申请文件的
   申请日提交的原始申请文件的权利要求第 项、说明书第 页、附图第 页；
   年 月 日提交的权利要求第 项、说明书第 页、附图第 页；
   年 月 日提交的权利要求第 项、说明书第 页、附图第 页；
   年 月 日提交的权利要求第 项、说明书第 页、附图第 页；
   年 月 日提交的说明书摘要， 年 月 日提交的摘要附图。
5. ☐本通知书是在未进行检索的情况下作出的。
   ☑本通知书是在进行了检索的情况下作出的。
   ☑本通知书引用下述对比文献(其编号在今后的审查过程中继续沿用)：

编号	文件号或名称	公开日期（或抵触申请的申请日）
1	CN-1247622 A	2000.03.15

中华人民共和国国家知识产权局 专利审查业务章 105

6. 审查的结论性意见：
   ☐关于说明书：

☐申请的内容属于专利法第 5 条规定的不授予专利权的范围。
☐说明书不符合专利法第 26 条第 3 款的规定。
☐说明书不符合专利法第 33 条的规定。
☐说明书的撰写不符合实施细则第 18 条的规定。
☐________

☑关于权利要求书：
☐权利要求________不具备专利法第 22 条第 2 款规定的新颖性。
☐权利要求________不具备专利法第 22 条第 3 款规定的创造性。
☐权利要求________不具备专利法第 22 条第 4 款规定的实用性。
☑权利要求1-20,24-27属于专利法第 25 条规定的不授予专利权的范围。
☐权利要求________不符合专利法第 26 条第 4 款的规定。
☐权利要求________不符合专利法第 31 条第 1 款的规定。
☐权利要求________不符合专利法第 33 条的规定。
☐权利要求________不符合专利法实施细则第 2 条第 1 款关于发明的定义。
☐权利要求________不符合专利法实施细则第 13 条第 1 款的规定。
☑权利要求___21___不符合专利法实施细则第 20 条的规定。
☐权利要求________不符合专利法实施细则第 21 条的规定。
☐权利要求________不符合专利法实施细则第 22 条的规定。
☐权利要求________不符合专利法实施细则第 23 条的规定。
☐________

上述结论性意见的具体分析见本通知书的正文部分。

7. 基于上述结论性意见，审查员认为：

☐申请人应按照通知书正文部分提出的要求，对申请文件进行修改。
☑申请人应在意见陈述书中论述其专利申请可以被授予专利权的理由，并对通知书正文部分中指出的不符合规定之处进行修改，否则将不能授予专利权。
☐专利申请中没有可以被授予专利权的实质性内容，如果申请人没有陈述理由或者陈述理由不充分，其申请将被驳回。
☐________

8. 申请人应注意下述事项：

(1) 根据专利法第 37 条的规定，申请人应在收到本通知书之日起的肆个月内陈述意见，如果申请人无正当理由逾期不答复，其申请将被视为撤回。
(2) 申请人对其申请的修改应符合专利法第 33 条的规定，修改文本应一式两份，其格式应符合审查指南的有关规定。
(3) 申请人的意见陈述书和/或修改文本应邮寄或递交国家知识产权局专利局受理处，凡未邮寄或递交给受理处的文件不具备法律效力。
(4) 未经预约，申请人和/或代理人不得前来国家知识产权局专利局与审查员举行会晤。

9. 本通知书正文部分共有___2___页，并附有下述附件：

☑引用的对比文件的复印件共___1___份___3___页。☐________

刘莹之印

审查员：刘莹(9609)
2004 年 4 月 11 日

审查部门　审查协作中心

21301
2002.8

回函请寄：100088 北京市海淀区蓟门桥西土城路 6 号　国家知识产权局专利局受理处收
（注：凡寄给审查员个人的信函不具有法律效力）

第 一 次审查意见通知书正文

审查员进行实质审查，具体审查意见如下。

（一）

权利要求 1-20、24-27 要求保护一种光盘，其上的第一和第二记录层具有相同的轨道螺旋方向。对比文件 1（CN-1247622 A）（其同族为本申请说明书背景技术中所列美国专利 US-5881032 A）公开了具有相同的轨道螺旋方向的双层光盘的结构。并在说明书第 2 页倒数第 2-3 段和附图 13A-13D 对其作出了具体描述，可以明确知道该双层光盘是具有相同的轨道螺旋方向结构的。本审查员认为，当对光盘要求进行保护时，应当对各层结构、形状、组成、材料的物理结构进行限定。权利要求 1 对于光盘结构的描述就仅限于上述对轨道螺旋方向的描述，除上述特征之外，其对地址的描述是光盘上所记载的信息而非物理结构的描述，对光盘没有限定作用，即本发明各权利要求所要求保护的光盘与现有技术（具体地，对比文件 1）相比在结构上没有变化，其对现有技术作出贡献的部分仅在于其上的信息。根据审查指南第二部分第九章第 2.1 节对专利法第二十五条第一款第（二）项作出解释的第（6）种情况，即，发明专利申请的主题名称为一种存储计算机程序的计算机可读存储介质，但是该计算机可读存储介质本身的物理特性没有发生任何变化，申请主题的实质是记录在该计算机可读存储介质上的计算机程序本身。由于计算机程序本身不给予专利保护，所以本发明不属于可给予专利保护的客体。权利要求 1-20，24-27 属于专利法第二十五条第一款第（二）项不授予专利权的发明，即，属于智力活动的规则和方法，因此其所要求保护的发明不属于可给予专利保护的客体。

权利要求 21 要求保护一种用于标识光盘上的记录层的方法。其中；关于物理地址不相同的表述不清楚，如将下述技术特征同时补入，可以克服第一和第二记录层具有相同的轨道螺旋方向时该技术方案不清楚的缺陷。即，

<从第一记录层的中心到其外侧，

1. 最小记录单元的物理地址与在盘上记录时所记录的最小记录单元的地址一起增加或减小的技术特征（权利要求 1 中所述）；或
2. 在盘上记录时所记录的最小记录单元的地址当最小记录单元的物理地址增加时减小、而当物理地址减小时增加的技术特征（权利要求 6 所述）>

与

<同时从第二记录层的中心到外侧，物理地址和在盘上记录时所记录的最小单元的地址连续地增加或减小。>

因此，权利要求 21 的撰写不符合专利法实施细则第二十条第一款关于权利要求书应当清楚、简要地表述请求保护的范围的规定。

（二）

本申请的说明书部分存在以下问题。

第 4 页第 15 行关于连续的含义希望和申请人探讨。第二层中心到外侧，物理地址和盘上记录期间所记录的地址是否是和第一层中的物理地址相连续？即，是否表示下述含义：例如，扇区物理地址从第一层中心到外侧分别为 0000H-1000H，并且第一层扇区物理地址和在盘上记录期间所记录的地址同增加或减小，则在第二层上扇区物理地址和盘上记录期间所记录的地址从 1000H+A（该 A 为某一地址预定跳转量），以此来实现第一层与第二层的连续；还是说就是单纯第二层内部实现连续？根据附图，似乎第一种是合适的，但审查员不是很确定，希望申请人给予解释，以实现对发明的更深刻的理解。

基于上述理由，本申请目前的文本还不能被授予专利权，申请人应当在本通知书指定的四个月答复期限内提交新修改的权利要求书和说明书，在意见陈述书中充分论述答复意见，解释审查员的疑问。修改时应注意满足专利法第三十三条的规定，即对发明专利申请文件的修改不得超出原说明书和权利要求书记载的范围。

Applicant:. SAMSUNG ELECTRONICS CO., LTD.	ISSUING DATE:
Agent: Ying Ma	2004. 4. 30.
Application No.: 02106402 4	
Title: OPTICAL DISC AND METHOD FOR ----	

THE FIRST OFFICE ACTION

1. ☒ The applicant filed a request for substantive examination on Year ___Month___Day___according to Article 35 Paragraph 1 of the Patent Law. The examiner has conducted a substantive examination to the above-mentioned patent application.

   ☐ According to Article 35 paragraph 2 of the Patent Law. Chinese Patent office decided on its own initiative to conduct a substantive examination to the above-mentioned patent application.

2. ☒ The applicant requested to take

   Year 01 Month 4 Day 1 on which an application is filed with the KR patent office as the priority date.

   Year______Month____Day____on which an application is filed with the_____patent office as the priority date.

   Year______Month____Day____on which an application is filed with the_____patent office as the priority date.

   ☒ The applicant has submitted the copy of the earliest application document certified by the competent authority of that country..

   ☐ According to Article 30 of the Patent Law, if the applicant has not yet submitted the copy of the earliest application document certified by the competent authority of that country, the declaration for Priority shall be deemed not to have been made.

   ☐This application is a PCT application.

3. ☐ The applicant submitted the amended document(s) on Year___Month___Day___and Year___Month____Day after examination, __________submitted on Year______Month____Day____is/are not accepted.

   __________submitted on Year______Month____Day____is/are not accepted

   because the said amendment(s) ☐ is/are not in conformity with Article 33 of the Patent Law.

   ☐ is/are not in conformity with Rule 51 of the Implementing Regulations..

   ☐The concrete reason(s) for not accepting the amendment(s) is/are presented on the text of Office Action.

4. ☒ The examination has been conducted based on the application text as originally filed.

   ☐ The examination has been conducted based on the following text(s):

   page(s)____of the specification, Claim(s)_____, and figure(s)_____in the original text of the application submitted on the filing day.

   page(s)_____of the specification, claim(s)_____, and figure(s)____submitted on Year___Month____Day___

   page(s)_____of the specification, claim(s)_____, and figure(s)____submitted on Year___Month____Day___

5. ☐This notification was made without undergoing search.

   ☒ This notification was made with undergoing search.

   ☒The following reference document(s) is/are cited:(the reference numeral(s) thereof will be used in the examination procedure hereafter)

NO.	Reference No. or Title	Publishing Date
1	CN-1247622A	2000.3.15
2		
3		
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6. Concluding comments

☐ on the specification:

☐ The contents of the application are in contrary to Article 5 of the Patent Law and therefore are not patentable.

☐ The contents of the application do not possess the practical applicability as prescribed in Paragraph 4 of Article 5 of the Patent Law.

☐ The specification is not in conformity with the provision of Paragraph 3 of Article 26 of the Patent Law.

☐ The presentation of the specification is not in conformity with the provision of Rule 18 of the Implementing Regulations.

☒ on the claims:

☒ Claim(s) 1-20, 24-27 belong(s) to non-patentable subject matter as prescribed in Article 25 of the Patent law.

☐ Claim(s)________ do(es) not comply with the definition of a patent as provided in Rule 2 paragraph 1 of the Implementing Regulations.

☐ Claim(s)________ do(es) not possess novelty as requested by Article 22 paragraph 2 of the Patent Law.

☐ Claim(s)________ do(es) not possess inventiveness as requested by Article 22 paragraph 3 of the Patent Law.

☐ Claim(s)________ do(es) not possess practical applicability as requested by Article 22 paragraph 4 of the Patent Law.

☐ Claim(s)________ do(es) not comply with the provision of Article 26 paragraph 4 of the Patent Law.

☐ Claim(s)________ do(es) not comply with the provision of Article 31 paragraph 1 of the Patent Law.

☒ Claim(s) 21 do(es) not comply with provision of Rules 20 of the Implementing Regulations.

☐ Claim(s)________ do(es) not comply with the provision of Article 9 of the Patent Law.

☐ Claim(s)________ do(es) not comply with the provision of Rule 12 paragraph 1 of the Implementing Regulations.

The detailed analysis for the above concluding comments is presented on the text of this Office Action.

7. Based on the above concluding comments, the examiner is of the opinion that

☐ The applicant should amend the application document(s) in accordance with the requirement as specified in the Office Action.

☒ The applicant should, in his observation, expound the patentability of the application of the application, amend the defects pointed out in the Office Action; or the application can hardly be approved.

☐ The examined deems that the application lacks substantive features to make it patentable. Therefore, the application will be rejected if no convincing reasons are provided to prove its patentability.

8. The applicant should pay attention to the following matters:

(1) According to Article 37 of the Patent Law, the applicant is required to submit his observations within Four months upon receipt of this Office Action. If the time limit for making response is not met without any justified reason, the application to have been withdraw.

(2) The amendment(s) made by the applicant must meet the requirements of Article 33 of the Patent Law. The amended text should be in duplicate, its format should conform to the related confinement in the Guidance for Examination.

(3) The applicant and/or the agent should not go to the Chinese Patent Office to interview the examiner without being invited.

(4) The observation and/of the amended document(s) must be mailed of delivered to the Receiving Section of the Chinese Patent Office. No legal effect shall apply for any document(s) that not mailed to or reached the Receiving Section.

9. The text of this Office Action contains 2 page(s), and has the following attachment(s):

☒ 1 copies of the cited references, all together 3 pages.

☐

Examination Dept. No.______ Examiner__________ Seal of Examination Dept. for business only ______

(if the Office Action wasn' t stamped by the specified seal, it has no legal effect)

TEXT OF THE FIRST OFFICE ACTION

The examiner performs substantive examination on the present application and provides detailed opinions as follows:

(I)

Claims 1-20 and 24-27 are for an optical disc on which the first and second recording layers have the same track spiral direction. Reference 1 (CN-1247622A) (its equivalent is the US patent US-5881032A listed in the background art of the specification of the present application) discloses a dual layer optical disk structure having the same track spiral direction and describe it in detail in the last line, page 2 to line 18, page 3 of the specification and Figs. 13A-13D. It can be known definitely that said dual layer optical disk has the structure of the same track spiral direction. The examiner considers that definitions should be made to the structure, shape, constitution and physical structure of material of each layer when seeking protection for an optical disk. The definitions to the optical disk structure in claim 1 only lie in the above description on the track spiral direction. Except the above feature, the description on address is on the information recorded on the optical disk rather than physical structure and does not have limiting function to the optical disc. That is, in comparison with the prior art (i.e. Reference 1 in detail), the optical disc sought for protection in the claims of the present invention does not have any change in structure. And the contribution said optical disc makes to the prior art only lies in the information therein. According to the sixth example given in the explanation to the provision of Article 25, clause 1, item (2) of the Chinese Patent Law made in Section 2.1, Chapter 9, Part II of the Examination Guidelines, i.e. the title of the subject matter of an application for a patent for invention is a computer-readable storage medium for storing computer programs. However, there is no change in the physical feature of the computer-readable storage medium. The essence of the subject matter of the application is the computer program per se which is recorded in the computer-readable storage medium. Because no patent protection may be provided to the computer program per se, this invention is not the object of patent protection. Claims 1-20 and 24-27 belong to the invention which no patent protection may be provided to as prescribed in Article 25, clause 1, item (2) of the Chinese Patent Law. That is, claims 1-20 and 24-27 belong to rules and methods for mental activities. Therefore, the invention sought for protection does not belong to the object to which patent protection may be provided.

Claim 21 defines a method for identifying a recording layer on an optical disc, wherein the description on that the physical address is different is not clear. If the following technical features are added into claim 21, then the defect that the technical solution of first and second recording layers having the same track spiral direction is not clear can be removed. Said technical features are:

<1. the technical feature that a physical address of smallest recording units increases or decreases together with an address of the smallest recording units recorded while

recording on the disc, from the center of the first recording layer to the outside thereof (as defined in claim 1); or

2. the technical feature that an address of smallest recording units recorded while recording the disc decreases when a physical address decreases (as defined in claim 6)>; and

<at the same time, a physical address of smallest recording units increases or decreases together with an address of the smallest recording units recorded while recording on the disc, from the center of the second recording layer to the outside thereof.

Therefore, the drafting of claim 21 does not comply with that the claims shall define clearly and concisely the matter for which protection is sought, as prescribed in Rule 20, paragraph 1 of the Implementing Regulations of the Chinese Patent Law.

(II)

The problems existing in the specification of the present application are found as follows:

The examiner desires to discuss the meaning of "continuously" in line 31, page 5 of the specification with the applicant. It is not clear whether the physical address and the address recorded while recording to the disc are continuous with the physical address in the first layer. In another word, it is not clear whether the specification expresses the following meaning: for example, the sector physical addresses are 0000H-1000H from the center of the first layer to the outside, and the sector physical address and the address recorded while recording to the disc in the first layer increase or decrease simultaneously, then the sector physical address and the address recorded while recording to the disc in the second layer start from 1000H+A so as to realize the continuousness between the first layer and the second layer; or alternatively, the specification only refer to realizing continuousness within the second layer. According to the drawings, it seems that the first explanation is appropriate. However, the examiner can not be quite certain. The applicant is invited to make further explanation so that the examiner may have an in-depth understanding on the present invention.

Due to the above reasons, the present application can not be granted a patent right under the current text. The applicant should submit new amended claims and specification within the four-month response time limit as designated in the present Office Action and discuss sufficiently the response in the Observation to make the doubt of the examiner clear. When making amendments, the applicant should note that the amendments made to the present invention patent application documents should not go beyond the initial disclosure of the specification and claims so as to comply with the provision of Article 33 of the Chinese Patent Law.

Description of correspondent: **WO9715050**

DESCRIPTION

INFORMATION STORAGE MEDIUM, INFORMATION REPRODUCING METHOD, AND INFORMATION REPRODUCING APPARATUS

Technical Field

The present invention relates to an information storage medium comprising plural information storage layers in a single disk-shaped information storage medium, to an information reproducing method for reproducing data in sector units from said information storage medium, and to an information reproducing apparatus implementing said information reproducing method.

Background Art

Conventional optical disks have only one recording layer, and no consideration has been given for optical disks having plural recording layers. Magnetic storage media, however, typically have plural recording layers on each magnetic disk. The structure of such a magnetic storage media is shown in Fig. 9.

A magnetic disk typically has plural disk-shaped magnetic storage mediaD1 and D2, and magnetic read/write heads M1, M2, M3 and M4 for four recording surfaces. The magnetic read/write heads M1, M2, M3 and M4 are provided at the end of swing arms Al, A2, A3 and A4 which are rotated simultaneously by the stepping motor.

This makes it possible to change the read/write recording surface by simply selecting the appropriate magnetic head.

Plural concentric tracks are formed on each recording surface, and each track is divided into plural sectors.

Each of these sectors typically has a 512-byte to 2048-byte capacity, and is used as the data recording unit. An address comprising the track number and sector number (also referred to as sector address) is written to the beginning of each sector. The magnetic disk drive depends on this address information to position the magnetic head. Track numbers are assigned in ascending order from the outside circumference to the inside circumference.

On a conventional optical disk, however, the recording track is formed as a spiral groove rather than concentric grooves. Except that the track shape is spiral, the track numbers and sector numbers of optical disk media standardized for data processing (e.g., 90 mm magneto-optical disks conforming to ISO-10090) are assigned in the same manner as on a magnetic disk.

The sector addresses on optical disk media developed first for audio storage and later adapted for data processing applications, i.e., CD-ROMs, are expressed in minutes, seconds, and frames.

disk surface. The disk is also driven with constant linear velocity (CLV) control to assure a constant data quantity reproduced per unit of time. CLV drive rotates the disk at a variable speed depending upon the radial disk position so that the beam spot focused on the disk by the optical head scans a constant distance per unit of time on the disk. Disks containing a constant recording density across the entire disk surface are therefore also known as CLV disks.

The sector arrangement on a CLV disk is shown in Fig. 10. Each fan-shaped block in Fig. 10 is a sector.

The sectors are contiguously connected in a spiral pattern.

Because the recording density is constant, every sector is the same size (capacity) from inside to outside circumference.

The internal structure of each sector is shown in Fig. 11. Each sector thus comprises a header containing the address uniquely identifying the sector, a data block to which user data is recorded, and an error correction code (ECC) block to which is recorded a code used for error correction during reproduction.

Advances in moving picture compression technologies in recent years have also made it possible to record substantially theater-quality moving pictures to a single optical disk. These disks are known as Digital Video Disks (DVD).

A single DVD can store approximately 135 minutes of high-quality moving pictures. Obviously, however, not all video sources are approximately 135 minutes long. It has therefore been proposed that the storage capacity could be approximately doubled by forming two recording layers on a single optical disk. The principle of reproducing data from a dual recording layer optical disk is shown in Fig. 12 and described below.

Strings of pits and lands are formed in a transparent substrate, which is then coated with aluminum, to form each recording layer. A transparent photosetting resin is injected between the first and second recording layers. The thickness of the aluminum on the first recording layer is adjusted to reflect half and pass half of the light incident thereon. The thickness of the aluminum on the second recording layer is adjusted to reflect all of the light incident thereon. The beam spot (focusing point) of the laser beam can be focused on the aluminum of the first or second recording layer by moving the objective lens that focuses the laser beam closer to or away from the optical disk.

The recording layers of the DVD medium are described below. As with conventional optical disks and magnetic disks, information is divided into sector units for recording to a DVD medium. The DVD sector arrangement of each recording layer is also like that of the CLV disk shown in Fig. 10. The internal structure of each sector is also the same as that of a conventional information storage medium as shown in Fig. 11.

Figs. 13A, 13B, 13C and 13D show the spiral grooves of a conventional

groove pattern on the first layer, Fig. 13B shows the spiral groove pattern on the second layer, Fig.

13C shows the rotational velocity of the disk, and Fig. 13D shows the reproduction direction. User data is recorded to the data blocks of the first and second layers as shown in
Fig. 13D. The sector address is also recorded to the lead-in and lead-out areas (shown shaded in the Fig. 13D) so that the current position can be determined when the head overruns the data block.

When the information storage medium is rotated clockwise, both first and second recording layers are reproduced from the inside circumference to the outside circumference. The rotational velocity of the information storage medium is also inversely proportional to the radius, and therefore decreases as the head moves from inside circumference to outside circumference. Thus, if reproduction is to continue from the first layer to the second layer, the head must be moved from the outside circumference to the inside circumference while simultaneously adjusting the rotational velocity of the medium.

When the information storage medium has two or more recording layers, there are two factors that must be considered when assigning the sector addresses. First, every address must be unique throughout the information storage medium. If the same address exists on the first and second layers, it is not possible to determine from the address alone whether the desired information is recorded on the first or second recording layer. Second, the addresses assigned to each layer should be easily convertible to an address on the first layer. This is because the address is the location information, and to move to the desired sector the movement distance must be calculated from the address.Particularly in a CLV information storage medium, the number of sectors per disk revolution is proportional to the radial position of the sector, and the sector number counted from the disk center is proportional to the surface area to the radial position of the sector. In other words, the groove number is in a square root relationship to the address of the sector counted from the disk center.

Apparatuses for reproducing a CLV disk must be able to calculate this square root in order to obtain the number of grooves the head must cross in order to be positioned to the desired sector. If converting the addresses on each layer to an address on the first layer is difficult, a different square root must be calculated for each layer.

Optical disk media standards generally define median and deviation values for the groove pitch and the radius of the groove closest to the inside circumference.

Therefore, if the address at the inside circumference is indefinite relative to the radius of the inside circumference groove, the number of variables in the calculation obtaining the above square root increases.

Thus, when the address at the inside circumference of each layer is indefinite, the time and tables required to calculate the square root increase. As a result, apparatuses for reproducing such disks incur cost increases from the square root

Conventionally, there has been proposed an optical disk having a plurality of recording layers to increase the recording capacity per one storage medium.

Such an optical disk uses opposite side faces of the information storage medium, as in the case of the magnetic disk. One example is disclosed in Japanese Laid-open Patent Publication No. H2-103732. This reference discloses that the spiral track on the first side and that on the second side are in opposite direction for enabling smooth continuous play from the first side to the second side.

However, all the conventional optical disks of the two recording layer type has the recording surfaces facing in opposite directions, and both surfaces have the same reflectivity. Thus, one optical head is provided on each side, thus in total two optical heads in one reproducing apparatus. The optical head is an expensive device, because it generally includes semi-conductor laser generator for the light source, optical devices for adjusting the light intensity, and electromagnetic coil for adjusting the focusing point. Therefore, the reproducing apparatus used in connection with the conventional optical disk of the two recording layer type is eventually a high cost apparatus.

Since there are two separate optical heads for the first and second sides of the optical disk, the first optical head for the first side surface may be located at the outer most track, whereas the second optical head for the second side surface may be located at the inner most track. Also, according to the recent development in the technology, which is called a jitter free reproduction technology, the reproduction can be properly carried out even when the disk rotation speed deviates from its proper speed.Therefore, in order to accomplish the smooth contiguous play from the first side to the second side, there is no limitation for the conventional two recording layer type optical disk to use a reproducing apparatus that moves the first head from inside to outside and then the second head from outside to the inside, or vice versa,i.e., the first head from outside to inside and then the second head from inside to outside. It is possible that the first head may reproduce from inside to outside, and then the second head may reproduce from inside to outside.

Also, according to the conventional optical disk of the two recording layer type, since two separate optical heads are necessary it is possible to use the same addresses between the first side and the second side.

As understood from the above, according to the conventional two recording layer type optical disk, no consideration has been made to enable the smooth contiguous play from the first side to the second side using only one optical head. For the conventional two recording layer type optical disk, a plurality of optical heads are provided for enabling smooth contiguous play from the first side to the second side. Alternatively, one way to solve is to move the heads instantaneously from inside to outside, or vice versa, and at the same time change the rotational speed of the disk. However, from a practical view point, such an apparatus is not realized.

A problem with the conventional information storage medium thus described is that the groove formation and addresses are determined without considering contiguous reproduction across plural recording layers. As a result, a loss of performance and

Disclosure of the Invention

To resolve the aforementioned problems, the present invention provides an information storage medium comprising plural recording layers wherein the spiral reproduction directions are opposite on even- and odd-numbered layers. In addition, the addresses assigned to sectors at the same radial positions on even- and odd-numbered layers are numbers in a complementary relationship.

An information reproducing method according to the present invention for reproducing data in sector units from an information storage medium having plural recording layers comprises a direction-of-spiral recognition step for recognizing the spiral direction of each layer, an address conversion step assigning contiguous logical space across plural layers in an information storage medium in which numbers in a complementary relationship are assigned as the addresses of sectors at the same radial positions on evenand odd-numbered layers, and a movement distance calculation step for obtaining the access distance to a particular address.

An information reproducing apparatus according to the present invention for reproducing data in sector units from an information storage medium having plural recording layers comprises a direction-of-spiral recognition means for recognizing the spiral direction on each layer, an address conversion means for assigning contiguous logical space across plural layers on an information storage medium in which numbers in a complementary relationship are assigned as the addresses of sectors at the same radial positions on even- and odd-numbered layers, and a movement distance calculation means for obtaining the access distance to a particular address.

According to one aspect of the present invention, an optical disk comprises:
at least first and second recording layers placed one over the other in such a manner that information recorded in each layer is optically readable from one side of the disk;
tracks formed on said first and second recording layers with a plurality of sectors provided along said tracks, said tracks on said first and second layers being in a spiral pattern and arranged such that the spiral patterns on the first and second layers have opposite winding directions when viewed from the same side of the disk.

According to another aspect of the present invention, an optical disk comprises:
at least first and second recording layers placed one over the other in such a manner that information recorded in each layer is optically readable from one side of the disk;
tracks formed on said first and second recording layers with a plurality of sectors provided along said tracks;;
sector addresses provided to said sectors, respectively, said sector addresses on said first recording layer increasing from one circumference side to an other circumference side, said one circumference side being either one of the most inside circumference and the most outside circumference, and said other circumference side being other one of the most inside circumference and the most outside circumference, and said sector addresses on the second recording layer increasing from said other circumference side to said one circumference side;

in complementary relationship.

According to yet another aspect of the present invention, an optical disk reproduction method for reproducing an optical disk having:
at least first and second recording layers placed one over the other in such a manner that information recorded in each layer is optically readable from one side of the disk;
tracks formed on said first and second recording layers with a plurality of sectors provided along said tracks;;
sector addresses provided to said sectors, respectively, said sector addresses on said first recording layer increasing from one circumference side to an other circumference side, said one circumference side being either one of the most inside circumference and the most outside circumference, and said other circumference side being other one of the most inside circumference and the most outside circumference, and said sector addresses on the second recording layer increasing from said other circumference side to said one circumference side;
said sector address on one layer and the sector address on the other layer, which are allocated to sectors in the tracks approximately corresponding to each other, being in complementary relationship, said method comprises the steps of::
detecting ascending direction of the sector address on the optical disk,
moving an optical head unit to a target position on the layer, and
reproducing the disk in a direction detected by said detecting step.

According to a further aspect of the present invention, an optical disk reproduction method for reproducing an optical disk having:
at least first and second recording layers placed one over the other in such a manner that information recorded in each layer is optically readable from one side of the disk;
tracks formed on said first and second recording layers with a plurality of sectors provided along said tracks;;
sector addresses provided to said sectors, respectively, said sector addresses on said first recording layer increasing from one circumference side to an other circumference side, said one circumference side being either one of the most inside circumference and the most outside circumference, and said other circumference side being other one of the most inside circumference and the most outside circumference, and said sector addresses on the second recording layer increasing from said other circumference side to said one circumference side;
said sector address on one layer and the sector address on the other layer, which are allocated to sectors in the tracks approximately corresponding to each other, being in complementary relationship, said method comprises the steps of::
detecting an address of a current sector to which the optical head unit is focused;
detecting the number of the recording layer to which the optical head unit is focused; and
converting the detected address, when the detected number of the recording layer is the second, to contiguous logical space which is in common with the address of the first recording layer.

According to a still further aspect of the present invention, an optical disk reproduction apparatus for reproducing an optical disk having:
at least first and second recording layers placed one over the other in such a manner

tracks formed on said first and second recording layers with a plurality of sectors provided along said tracks;;
sector addresses provided to said sectors, respectively, said sector addresses on said first recording layer increasing from one circumference side to an other circumference side, said one circumference side being either one of the most inside circumference and the most outside circumference, and said other circumference side being other one of the most inside circumference and the most outside circumference, and said sector addresses on the second recording layer increasing from said other circumference side to said one circumference side;
said sector address on one layer and the sector address on the other layer, which are allocated to sectors in the tracks approximately corresponding to each other, being in complementary relationship, said apparatus comprises::
means for detecting ascending direction of the sector address on the optical disk, means for moving an optical head unit to a target position on the layer, and reproducing the disk in a direction detected by said detecting means.

According to another aspect of the present invention, an optical disk reproduction apparatus for reproducing an optical disk having:
at least first and second recording layers placed one over the other in such a manner that information recorded in each layer is optically readable from one side of the disk;
tracks formed on said first and second recording layers with a plurality of sectors provided along said tracks;;
sector addresses provided to said sectors, respectively, said sector addresses on said first recording layer increasing from one circumference side to an other circumference side, said one circumference side being either one of the most inside circumference and the most outside circumference, and said other circumference side being other one of the most inside circumference and the most outside circumference, and said sector addresses on the second recording layer increasing from said other circumference side to said one circumference side;
said sector address on one layer and the sector address on the other layer, which are allocated to sectors in the tracks approximately corresponding to each other, being in complementary relationship, said apparatus comprises: :
means for detecting an address of a current sector to which the optical head unit is focused;
means for detecting the number of the recording layer to which the optical head unit is focused; and
means for converting the detected address, when the detected number of the recording layer is the second, to contiguous logical space which is in common with the address of the first recording layer.

Brief Description of the Drawings
The present invention will become more fully understood from the detailed description given below and the accompanying diagrams wherein:
Figs. 1A and 1B show spiral grooves in two recording layers according to the present invention.

Fig. 1C is a graph showing a rotational velocity.

Fig. 1D ia a diagram showing reproduction directions of an information storage

Fig. 2 is a diagram showing reproduction directions on an information storage medium comprising four recording layers according to a first embodiment of the present invention.

Fig. 3 is a diagram showing a manner for assigning address on an information storage medium comprising two recording layers according to a second embodiment of the present invention.

Fig. 4 is a diagram showing a manner for assigning address on an information storage medium comprising four recording layers according to a second embodiment of the present invention.

Fig. 5 is a block diagram of an information reproducing apparatus according to the third embodiment of the present invention.

Fig. 6A is a flow chart showing an operation for detecting the spiral reproduction direction of each layer according to the third embodiment of the present invention.

Fig. 6B is a flow chart showing a modification of the flow chart shown in Fig. 6A.

Fig. 7A is a flow chart showing an operation for converting the detected sector address to a contiguous logical space across plural layers according to the fourth embodiment of the present invention.

Fig. 7B is a flow chart showing an operation for converting the contiguous logical space to the sector address across plural layers according to the fourth embodiment of the present invention.

Fig. 8 is a flow chart showing an operation for calculating an amount of move of the optical head for shifting from the current position to a target position.

Fig. 9 is a diagram showing a prior art magnetic disk comprising plural recording surfaces.

Fig. 10 is a top plan view of a constant linear velocity (CLV) disk.

Fig. 11 is a diagram showing internal sector structure of a disk.

Fig. 12 is a diagram showing an optical disk with two recording layers.

Figs. 13A and 13B show spiral grooves in two recording layers according to the prior art.

Fig. 13C is a graph showing a rotational velocity.

Fig. 13D ia a diagram showing reproduction directions of an information storage medium comprising two recording layers according to the prior art.

Best Mode for Carrying Out the Invention

reproduced across plural recording layers. In each recording layer of ... information storage medium having plural recording layers, the address of each sector in layer Ln (where n2 2) is obtained from a logic operation containing a complementary operation on the address assigned to the sector at the same radial position in the first layer. Data reproducing operations from contiguous sector units spanning plural recording layers thus reproduce data in increasing sector number sequence.

It is also possible to provide an information reproducing apparatus capable of recognizing the reproduction direction of the spiral recording patterns on an information storage medium comprising plural recording layers. When the reproduction directions of the spiral recording patterns on different recording layers of the information storage medium differ, it is also possible for said information reproducing apparatus to create contiguous logical space spanning plural recording layers, and access any desired address on the information storage medium.

As a result, it is possible to provide at low cost and with high performance an information reproducing apparatus capable of contiguously reproducing data from plural recording layers.

The preferred embodiment of an information storage medium according to the present invention is described below with reference to the accompanying figures.

Figs. 1A, 1B, 1C and 1D show, respectively, spiral grooves on first and second layersL1 and L2, rotational velocity, and reproduction directions of an information storage medium, i.e., an optical disk. The optical disk according to the first embodiment of the present invention comprises first and second recording layersL1 and L2. Fig. 1A shows the spiral groove pattern on the first layer L1, Fig. 1B shows the spiral groove pattern on the second layer L2, Fig. 1C shows the rotational velocity of the disk, and Fig.1D shows the reproduction direction. User data is recorded to the data blocks of the first and second layersL1 and L2 as shown in Fig. 1D.The sector address is also recorded to the lead-in area la and lead-out arealb, as shown in Fig. 13D, so that the current position can be determined when the head overruns the data block.

The first feature of the present invention is that the sector address X on the first layerL1 and the sector address X' on the second layer L2 are in the complementary relationship with each other. Ideally, the sectors addresses X and X' are opposing to each other, but from the purpose of the present invention, the sector addresses X and X' are in the tracks of the same number of turns counted from the most inner track, or in vicinity of such tracks. Two major advantages provided by the first feature are as follows.

The first advantage is that a contiguous logical space at the outer (or inner) most sector address of the first layer and that of the second layer.can be obtained. This is explained in detail in connection with
Fig. 7A.

The second advantage is that the rate of change of the sector address in the first layer and that in the second layer are in a symmetrical relationship about the disk. This is explained in detail in connection with Fig.

When the information storage medium is rotated clockwise, the first recording layerL1 is reproduced from the inside circumference to the outside circumference.

With constant linear velocity (CLV) drive control, the rotational velocity of the information storage medium is inversely proportional to the radius as shown in Fig. 1C.

Therefore, when the head is positioned at any given radial position on the disk, the rotational velocity is the same on both the first and second layersL1 and L2.

When reproduction is switched from the first layer L1 to the second layer L2 as shown in Fig. 1D, it is not necessary to change the direction of disk rotation when switching from the first to the second layer, and it is not necessary to move the head from the outside circumference to the inside circumference.

Fig. 2 shows the reproduction directions on an information storage medium with four recording layers L1,
L2, L3 and L4. The first and third layersL1 and L3 in this example are reproduced from inside to outside circumference, and the second and fourth layers L2 and L4 are reproduced from outside to inside circumference. As when switching from the first to second recording layers as described above, it is not necessary to change the direction of disk rotation or to move the head when switching from the second to third recording layer, or from the third to fourth recording layer.

When applied to a digital video disk medium to which moving pictures are recorded the practical effect of this switching method is particularly great because the delay of switching layers is directly related to intermitting the video reproduction.

It is therefore possible as described in the first embodiment of the present invention above to provide an information storage medium from which information can be contiguously reproduced across plural recording layers.

Note, however, that if the addressing method used with conventional information storage media is used on information storage media in which the data recording grooves are formed to enable contiguous reproduction from the first to the second layer, the first recording layer will be reproduced in the normal ascending order, but the second recording layer will be reproduced in descending order. Using the minute-second-frame addressing scheme of an audio CD, this would result in the minute, second, and frame values decreasing as reproduction of the title continues on the second recording layer.

In addition, if the address following the address of the last outside circumference sector on the first recording layer is assigned as the address of the first sector at the outside circumference of the second recording layer (the first second-layer sector reproduced after the last first-layer sector is reproduced) , all sector addresses on the second layer will be dependent upon the address of the last sector on the first layer, and no second layer sector address can be discretely determined.

is X+1; then all second layer secto. addresses are dependent on the v...e of X. Note, further, that the address of the last outside circumference sector is indefinite on audio CDs.

The second feature of the present invention is that the disk has a plurality of recording layers wherein the reproduction directions are opposite on even- and odd-numbered layers. Thus, according to the present invention, when the tracks are presented in a spiral pattern, such as shown in Fig. 10, the spiral pattern of the first layerL1 and that of the second layer L2, when viewed from the laser beam source such as shown in Fig. 12, are in opposite direction winding. The spiral pattern shown in Fig. 10 is referred to as having a counterclockwise winding. Thus, it can be said that, when the disk is viewed from the objective lens shown in Fig. 12, the first layerL1 has a counterclockwise winding and the second layer L2 has a clockwise winding. This is also shown in Figs.1A and 1B.

The above arrangement according to the present invention, can be accomplished by preparing two transparent layers, each layer having a pattern similar to that shown in Fig. 10. The difference between the two layers is the specific data recorded along the spiral track. Then, the track engraved surface of one layer is mirror finished, and the track engraved surface of the other layer is halfmirror finished, for example, depositing an aluminum film.

Then, as shown in Fig. 12 the two layers are bonded together with the track engraved surfaces facing each other, and photosetting resin TR deposited between the surfaces. Thus, when viewed from one side of the disk, the spiral in one layer has a counterclockwise winding direction and the spiral in the other layer has a clockwise winding direction. This arrangement has the following advantages.

The first advantage is that the reproduction direction of one layer is from inside to outside circumference track, and that of the other layer is from outside to inside circumference track, or vice versa.

Thus, one reciprocal movement, from inside to outside and from outside to inside, of the optical head is sufficient to reproduce both layers.

Another advantage is that the same cutting apparatus for cutting the die for molding the layers can be used. As apparent from the above, the first and second layers have the same spiral winding direction when viewed onto the engraved surface. Thus, the cutting apparatus for cutting the die for molding the layers needs to cut the die only in one spiral winding direction.

Fig. 3 shows the method of assigning addresses to a dual layer information storage medium according to a second embodiment of the present invention. In this embodiment the address of a second layer sector is the complement X' (prime (') indicates complement) of the address X of the first layer sector at the same radial position r. For example, if the address of a given sector in the first layerL1 is 030000h, the sector on the second layer at the same radial position is FCFFFFh (where "h" indicates a hexadecimal numbering system) . This can be obtained by the following four steps.

(3) 1111 1100 1111 1111 1111 1111 bit inverted
(4) F C F F F F hexadecimal
Note that the functions of the shaded areas in Fig. 3 are the lead-in area la and lead-out area lb.

In the white area, which is a user data area, between the lead-in and lead-out areas la and lb on the first layer, the address of the sector at radius Rin at the inside circumference of the first layer is assumed to be Xin in this example and the address of the sector at radius Rout at the outside circumference is Xout, where Xin < Xout. The first layer sector addresses are assigned in ascending order from inside circumference to outside circumference, and by assigning the complement of the first layer sector address at the same radial position as the second layer sector address, the second layer sector addresses are assigned in ascending order from outside to inside circumference.As a result, when data is reproduced from each sector in the reproduction direction shown in Fig. 1D, the sector addresses continue in ascending order from the first layer to the second layer, as will be explained later with reference to Fig. 7A.

When the information storage medium has four recording layers, sectors on the respective layers can be addressed by simply adding a high bit indicating whether the addressed sector is on the first or second return in the reproduction direction shown in Fig. 2.

Fig. 4 shows the addressing method of an information storage medium comprising four recording layers L1, L2, L3 and L4 according to a second embodiment of the invention. With this method, the sector addresses on the second, third, and fourth layers at the same radial position as the sector at address 0030000h on the first layer areOFCFFFFh, 1030000h, and lFCFFFFh, respectively.

When data is read from sectors written in the reproduction direction shown in Fig. 2, the sector addresses thus continue to rise in ascending order from the first through the fourth layers. As a result, the bit indicating the first or second return in the reproduction direction and the most significant bit (MSB) of the rest of the address will be 00b, 01b, 10b, and llb (where "b" indicates a binary value), respectively, for every sector on the first, second, third, and fourth layers. It is therefore possible to identify in which recording layer each sector resides by reading these two bits.

In an information storage medium comprising plural recording layers according to the second embodiment of the present invention as thus described, the address of each sector on layer Ln (where n2 2) is obtained by means of a logic operation including a complementary operation on the address.assigned to the first layer sector at the same radial position. As a result, data reproduced in sector units from sectors contiguously addressed across plural recording layers will be reproduced in ascending sector number sequence.

Fig. 5 is a block diagram of an information reproducing apparatus according to a third embodiment of the invention. Shown in Fig. 5 are the optical disk 1, disk

error correction circuit 12, CPU 13, rotation detection signal 14, disk motor drive signal 15, laser drive signal 16, photodetection signal 17, servo error signal 18, actuator drive signal 19, carriage drive signal 20, analog data signal 21, digital data signal 22, demodulated data signal 23, error-corrected data signal 24, and internal bus 25.

The lens 3, actuator 4, photodetector 6, laser drive circuit 5 and carriage 7 define an optical head unit.

The CPU 13 controls the overall operation of the information reproducing apparatus according to the control program stored therein via the internal bus 25.

Light reflected from the optical disk 1 is converted to a photodetection signal 17 by the photodetector 6, power-adjusted by the pre-amplifier 8, and converted to the servo error signal 18 and analog data signal 21. The analog data signal 21 is then analog/digital (A/D) converted by the binarization circuit 10 to produce the digital data signal 22, which is then demodulated by the demodulation circuit 11 to produce the demodulated data signal 23. The demodulated data signal 23 is then error corrected by the error correction circuit 12, which outputs the error-corrected data signal 24. The servo error signal 18 is fed back by the servo circuit 9 as the actuator drive signal 19 to the actuator 4, and used for focusing and tracking control of the lens 3.

In a DVD-ROM drive used as a CD-ROM drive or similar computer peripheral device, a host interface circuit (not shown in the figures) is also provided to receive the error-corrected data signal 24 from the error correction circuit 12, and communicate data with the host computer (not shown in the figures) via a host interface (SCSI or other, also not shown in the figures). In CD players and DVD players for consumer use, an A/V decoder (not shown in the figures) for expanding the compressed audio and video data is also provided. The error-corrected data signal 24 from the error correction circuit 12 is then applied to this A/V decoder, and the expanded audio and video signals are output through the appropriate video terminals (not shown in the figures).

Because the reproduction procedure of the information reproducing apparatus according to this third embodiment of the invention reproduces a dual-layer information storage medium in which the addresses on the first and second layers are mutually complementary, the following three processes are required for reproduction.

(1) Recognize the reproduction direction of the spiral recording pattern on each layer.

(2) Convert the sector addresses to a contiguous logical space across plural layers.

(3) Obtain the movement distance to the desired address on each layer.

Fig. 6A is a flow chart used to describe the direction-of-spiral recognition means for recognizing the reproduction direction of the spiral recording pattern on each layer according to the third embodiment of the present invention. It is assumed in

The first step 601 of this process stores the sector address X of the present position, i.e., the current sector address.

At step 602 the optical head is moved to the outside circumference by a predetermined amount.

Step 603 stores the sector address Y of the present position.

Step 604 compares the addresses X and Y, and branches to step 605 if X < Y, branches to step 606 if not X < Y.

Step 605 determines that the reproduction direction of the first layer is from inside circumference to outside circumference.

Step 606 similarly determines that the reproduction direction of the first layer is from outside circumference to inside circumference.

At step 607 the servo circuit 9 is instructed to change the focusing position to the second layer.

Step 608 stores the sector address X of the present position.

At step 609 the optical head is moved to the outside circumference by a predetermined amount.

Step 610 stores the sector address Y of the present position.

Step 611 compares the addresses X and Y, and branches to step 612 if X < Y, branches to step 613 if notX < Y.

Step 612 determines that the reproduction direction of the first layer is from inside circumference to outside circumference.

Step 613 similarly determines that the reproduction direction of the first layer is from outside circumference to inside circumference.

Fig. 6B is also a flow chart used to describe the direction-of-spiral recognition means, in a modified manner, for recognizing the reproduction direction of the spiral recording pattern on each layer according to the third embodiment of the present invention. It is assumed in this example that when the direction of the spiral on a given layer is from the inside circumference to the outside circumference, the MSB of the addresses on that layer is0 due to complementary relationship between the addresses on the layers, and assumed that the optical head is presently focusing on the first layer. Similarly, when the direction of the spiral on a given layer is from the outside to the inside circumference, the MSB of the addresses on that layer is 1.

The first step 621 of this process evaluates the MSB of the address for the current sector, and branches to step 622 if the MSB is 0, and to step 623 if the MSB is 1.

inside circumference to outside circumference.

Step 623 similarly determines that the reproduction direction of the first layer is from outside circumference to inside circumference.

At step 624 the servo circuit 9 is instructed to change the focusing position to the second layer.

At step 625 the MSB of the address for the current sector on the second layer is evaluated, and control branches to step 626 if the MSB is 0, and to step 627 if the MSB is 1.

Step 626 thus determines that the reproduction direction of the second layer is from inside circumference to outside circumference.

Step 627 similarly determines that the reproduction direction of the second layer is from outside circumference to inside circumference.

It is therefore possible by means of the third embodiment of the invention to provide an information reproducing apparatus capable of recognizing the reproduction direction of spiral recording paths on an information storage medium comprising plural recording layers.

After the spiral winding direction is detected,i.e., the ascending direction of the sector address is detected, the optical head is shifted to the target position. Here, the target position is a calculated target position which is slightly different from the operator's requested target position. For example, when theoperators requested target position is at a sector with address 50000h, the calculated target position to which the optical head is actually shifted is 4FFF6h, which is ten (10) sectors retreated from the operator's requested target position. By the detection of the spiral winding direction, the calculation of the sector address located at not advanced but retreated position from the operator's requested target position can be accomplished.It is noted that the maximum amount of retreat from the operator's requested target position is about one turn of the track.

Thereafter, when the optical head is shifted to the calculated target position, the reproduction is carried out just before the operator's requested target position.

It will be obvious that the invention shall not be limited to the relationship described above between the
MSB value of each sector address and the direction of the spiral pattern on each layer, and the same effect can be achieved if an MSB of 1 signifies that the reproduction direction of the spiral pattern is from inside circumference to outside circumference, and an MSB of0 signifies that the reproduction direction of the spiral pattern is from outside circumference to inside circumference.

Figs. 7A and 7B are flow charts used to describe the address conversion means for assigning contiguous logical space across plural layers according to the third embodiment of the present invention. In this example as above, when the direction of the spiral on a given layer is from the inside circumference to the outside

spiral is from the outside to the inside circumference, the MSB of the addresses on that layer is 1.

Fig. 7A is the flow chart for converting from addresses expressed by a variable X on the information storage medium shown in Fig. 3 to a contiguous logical space, i.e., to a sequential value for use in the host computer expressed by a variable N. Here, the variable X represents the actual sector address written on the optical disk and the variable N represents the converted sector address number used in the host computer in the reproducing apparatus. Also, in the calculations shown below a constant Xout represents an outer most circumference sector address, a constant Xin represents an inner most circumference sector address, and Xout' represents a complement of Xout. The constant Xin is not equal to zero, but is set to a predetermined number, such as 030000h.The constants Xout and Xin are previously stored in the lead-in area of the optical disk, and can be detected by the apparatus upon insertion of the disk.

The first step 701 reads the address of the current sector where the optical head is presently located, and converts the address to a variable X.

The next step 702 evaluates the MSB of variable X, and branches to step 704 if its MSB is 0, and to step 703 if its MSB is 1.

At step 703 the value (2 x Xout + 2) is added to variable X. (Because -Xout' = Xout + 1, X t X - Xout' + Xout + 1 is the same as X- X + Xout + 1 + Xout + 1, resulting in simple calculation.)
At step 704 the difference (variable X - Xin) is substituted for variable N.

The variable N obtained through the flow chart shown in Fig. 7A becomes a contiguous address value starting from 0 in the white region bounded by the shaded areas in the first and second layers, so that the host computer can regard the disk comprising the two layers as having only one layer with double capacity. In other words, the host computer recognizes the most outside sector address on the first layer and that on the second layer as a consecutive number without any gap or interruption therebetween.

An example of such calculations particularly for the most outside sector addresses Xout and Xout' is given below. It is assumed that,
Xin = 030000h and
Xout = 060000h.

Since Xout' is a complement of Xout, Xout' can be calculated by the following equation (1).

Xout' =1000000h - 1 - 060000h = F9FFFFh (1) .
When the operation is carried out through steps 701, 702 and 704 for processing the address data on the first side, the following calculation (2) is carried out in step 704. It is assumed that the present head position is at Xout.

N = Xout - Xin = 060000h - 030000h = 030000h (2)
This indicated that the outer most sector address of the first side of the disk is

When the operation is carried out through steps 701, 702, 703 and 70 . for processing the address data on the second side, the following calculation (3) is carried out in step 704. It is assumed that the present head position is at Xout'.

N = Xout' + (2 x Xout + 2) - Xin
= F9FFFFh + 060000h + 060000h + 2 - 030000h
= FFFFFFh + 060000h + 2 - 030000h
= 105FFFFh + 2 - 030000h
(MSB of the first term overflows)
= 060001h - 030000h = 030001h (3)
This indicates that the outer most sector address of the second side of the disk is recognized as 030001h in the host computer. Thus, calculations (2) and (3) indicates that the outer most sector addresses of the first and second sides are recognized as a consecutive numbers in the computer, i.e., in the contiguous logical space.

Fig. 7A is the flow chart for converting from the contiguous logical space expressed by N to a specific sector address expressed by X for the information storage medium shown in Fig. 2.

At step 711 the value (N + Xin) is substituted for variable X.

At step 712 variable X is evaluated, and if greater than Xout, control passes to step 712. Otherwise the process terminates.

At step 713 X is reassigned to the difference (X - (2 x Xout + 2))
The values X obtained from the flow chart in
Fig. 7B are assigned as the sector addresses of the information storage medium shown in Fig. 3.

It is thus possible as described above according to the third embodiment of the invention to provide an information reproducing apparatus whereby a contiguous logical space spanning plural recording layers can be created on an information storage medium in which the reproduction direction of the spiral pattern differs on alternating layers.

It will be obvious that the invention shall not be limited to the relationship described above between the
MSB value of each sector address and the direction of the spiral pattern on each layer, and the same effect can be achieved if an MSB of 1 signifies that the reproduction direction of the spiral pattern is from inside circumference to outside circumference, and an MSB of0 signifies that the reproduction direction of the spiral pattern is from outside circumference to inside circumference.

The relationship between address and groove position in a CLV medium is described next.

Because the groove width d is constant throughout the information storage medium, the relationship between the radius r and the groove number T counted from the inside circumference is defined by equation (4) below in the first layer.

Because the recording density is also constant throughout the information storage medium, the areas yielded by the right and left sides of equation (5) are equal in the first layer, wherein r is radius, and (X-Xin) is an address difference between the address Xin at the inside circumference and the present address X.

(X-Xin) x s x d =ir x (r x r - Rin x Rin) (5)
Here s is the sector length, d is the groove width, andX is pi (the ratio of the circumference of a circle to its diameter). If the radius r is eliminated from equations (4) and (5), the relationship between address X and the groove number T counted from the inside circumference is defined in the first layer by equation (6) below.
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It is noted that equation (5) can be satisfied for the first and second layers only when the rate of change of the sector address in the first layer and that in the second layer are in a symmetrical relationship about the disk, such as shown in Fig. 3. The same rate of change of the sector address in the first layer and that in the second layer can be accomplished by selecting the sector addresses of the first and second layers in complemental relationship with each other.

Fig. 8 is a flow chart used to describe the movement distance calculation means for obtaining the movement distance to a target address according to the third embodiment of the present invention. In this example as above, when the direction of the spiral on a given layer is from the inside circumference to the outside circumference, the MSB of the addresses on that layer is 0, and when the direction of the spiral is from the outside to the inside circumference, the MSB of the addresses on that layer is 1. It is further assumed that the target sector address to which the optical head is to be shifted is calculated in CPU 13 as a variable value Z.

The first step 801 of this process evaluates the MSB of the variable Z, and branches to step 802 if the
MSB is 0, and to step 803 if the MSB is 1.

At step 802 Z is substituted for X.

At step 803 the complement of Z is substituted for X.

At step 804 the value T obtained from equation (6) is assigned as the target groove number W (number of grooves counted from the most inside circumference).

At step 805 the address of the current sector is read and defined as variable X.

At step 806 the MSB values of X and Z are compared. If X and Z are equal, the process steps to step 811; otherwise, the process branches to step 807.

If the MSB of the variable X is0 at step 807, the process branches to step 808 if the MSB is 0, and to step 809 if the MSB is 1.

At step 808 the servo circuit 9 is instructed to move the focusing point to the

information storage medium comprising plural recording layers. When the reproduction directions of the spiral recording patterns on different recording layers of the information storage medium differ, it is also possible for said information reproducing apparatus to create contiguous logical space spanning plural recording layers, and access any desired address on the information storage medium.

As a result, it is possible to provide at low cost and with high performance an information reproducing apparatus contiguously reproducing data from plural recording layers.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.